


PCT/PTO 12 SEP 2001

FORM PTO-1390		U.S. Department of Commerce Patent and Trademark Office	Attorney's Docket No. 2576-118
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. Application No. (if known, see 37 CFR 1.5) Not Yet Assigned 09/936294
INTERNATIONAL APPLICATION NO. PCT/JP00/00103 ✓	INTERNATIONAL FILING DATE January 12, 2000 ✓	PRIORITY DATE CLAIMED	
TITLE OF INVENTION MOBILE COMMUNICATION TERMINAL AND METHOD OF COMMUNICATION ✓			
APPLICANT(S) FOR DO/EO/US Yuji KAKEHI ✓			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<div>1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371</div> <div>2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.</div> <div>3. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</div> <div>4. <input type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</div> <div>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))<div>a. <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).</div><div>b. <input checked="" type="checkbox"/> has been transmitted by the International Bureau.</div><div>c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US)</div></div> <div>6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</div> <div><input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))<div>a. <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).</div><div>b. <input type="checkbox"/> have been transmitted by the International Bureau.</div><div>c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.</div><div>d. <input checked="" type="checkbox"/> have not been made and will not be made.</div></div> <div>7. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</div> <div>8. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).</div> <div>9. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).</div>			
ITEMS 11. TO 16. below concern other document(s) or information included:			
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.			
12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.			
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <div><input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.</div>			
14. <input checked="" type="checkbox"/> A substitute specification.			
15. <input type="checkbox"/> A change of power of attorney and/or address letter.			
16. <input checked="" type="checkbox"/> Other items or information: Courtesy copy of International Application PCT/JP00/00102 w/attached International Search Report in Japanese and English; 9 sheets of drawings; 13 cited references, Form PCT/IB/301 and Form PCT/IB/308.			

09/936294

U.S. APPLICATION NO. (if known, see 37 CFR 1.53) Not Yet Assigned 09/938294		INTERNATIONAL APPLICATION NO. PCT/JP00/00103		ATTORNEY DOCKET NO. 2576-118	
17. [X] The following fees are submitted: Basic National Fee (37 CFR 1.492)(a)(1)-(5): Search Report has been prepared by the EPO or JPO \$ 860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) \$ 690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$ 710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$ 1,000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$ 100.00 ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 860.00				<u>CALCULATIONS</u>	<u>PTO USE ONLY</u>
Surcharge of \$130.00 for furnishing the oath or declaration later than [] 20 [] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$	
Claims	Number Filed	Number Extra	Rate		
Total Claims	18 -20 =	0	X \$18.00	\$	
Independent Claims	4 -3 =	1	X \$80.00	\$ 80.00	
Multiple dependent claim(s) (if applicable)			+ \$270.00	\$	
TOTAL OF ABOVE CALCULATIONS =				\$ 940.00	
Reduction by 1/2 for filing by small entity, if applicable. Applicant(s) hereby claim small entity.				\$	
SUBTOTAL =				\$ 940.00	
Processing fee of \$130.00 for furnishing the English translation later [] 20 [] 30 than months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 940.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 940.00	
				Amount to be refunded	\$
				charged	\$
a. <input checked="" type="checkbox"/> A check for \$ 940.00 to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. 02-2135 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-2135. A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Payment by credit card. (Form PTO-2038 enclosed.) NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO: George R. Repper Rothwell, Figg, Ernst & Manbeck 555 13th St., N.W. Washington, D.C. 20004 Phone: 202/783-6040			 Signature George R. Repper Name 31,414 Registration Number		

202/783-6040

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE	<i>Application Number</i>	§371 of PCT/JP00/00103
	<i>Filing Date</i>	September 12, 2001
	<i>First Named Inventor</i>	Yuji KAKEHI
	<i>Group Art Unit</i>	Unassigned
	<i>Examiner Name</i>	Unassigned
	<i>Attorney Docket Number</i>	2576-118
<i>Title of the Invention: Mobile Communication Terminal and Method of Communication</i>		

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Please amend the above-identified U.S. patent application as follows:

IN THE SPECIFICATION:

Please amend the specification as shown in the attached copy labelled "Marked-up copy of Amended Specification". A clean copy of the specification is provided as Tab 14.

IN THE CLAIMS:

Please amend claims 1-17 as follows. A marked-up copy of the amended claims is attached.

20110914 15:29:59

Clean copy of Amended Claims:

1. (Amended) A mobile communication terminal comprising:
 - a receiver (2) receiving a radio wave from base stations;
 - a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);
 - a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);
 - a decoder (9) decoding data demodulated by said demodulator (8); and
 - a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.
2. (Amended) The mobile communication terminal according to claim 1, wherein said control unit (4) determines the invalid cell based on information received from the base station, and stops the processing of said cell.
3. (Amended) The mobile communication terminal according to claim 2, wherein said detector (5, 6, 7) includes:
 - a slot timing detector (5) detecting slot timing from the signals received by said receiver (2),
 - a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5) from the signals received by said receiver (2), and
 - a code detector (7) detecting a code based on the slot timing detected by said slot timing detector (5) and the code group detected by said code group detector (6) from the signals received by said receiver (2).
4. (Amended) The mobile communication terminal according to claim 3, wherein said control unit (4) stops the processing of received signals when the code group detected by said code group detector (6) is not a predetermined code.
5. (Amended) The mobile communication terminal according to claim 4, wherein said code group detector (6) includes:

a plurality of code generators (15-1 - 15-N), each of said code generators (15-1 - 15-M) generating a code corresponding to a different code group,

a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and

a determining unit (18) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. (Amended) The mobile communication terminal according to claim 3, wherein said control unit (4) stops the signal processing of the cell search if the code detector (7) detects a code group other than a code group including the predetermined code.

7. (Amended) The mobile communication terminal according to claim 6, wherein said code detector (7) includes:

a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,

a dummy code generator (19-(M+1) - 19-N) generating a dummy code different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N), and

a determining unit (22) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8); and

a control unit (4) dividing a slot into a plurality of search ranges,
deleting multipath in said search range, successively allowing said demodulator (8)
to demodulate the received signals and allowing said decoder (9) to decode the
demodulated data.

9. (Amended) The mobile communication terminal according to claim 8, wherein
said control unit (4) stops the decode processing if the decoded data in said
search range is invalid data.

10. (Amended) A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
demodulating the received signals with said detected spread codes;
decoding said demodulated data; and
controlling cell search process, and stopping signal processing of the cell search
if said demodulated data is invalid cell.

11. (Amended) The communication method according to claim 10, wherein
said step of stopping the signal processing of the cell search includes the step of
determining invalid cell based on information received from the base station, and
stopping the signal processing of the cell search.

12. (Amended) The communication method according to claim 11, wherein
said step of detecting the spread codes includes the steps of:
detecting slot timing from said received signals,
detecting a code group based on said detected slot timing from said received
signals, and
detecting a code based on said detected slot timing and said detected code
group.

13. (Amended) The communication method according to claim 12, wherein
said step of stopping the signal processing of the cell search includes the step of
stopping the signal processing of the cell search if the code group received from the
base station is not a code group including a predetermined code.

14. (Amended) The communication method according to claim 13, wherein said step of stopping the signal processing of the cell search includes the steps of:

generating codes corresponding to a plurality of different code groups,
generating a dummy code different from said plurality of generated code groups,
calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and
determining invalidity of the detected code group based on a result of said calculation.

15. (Amended) The communication method according to claim 12, wherein said step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code received from the base station is not a predetermined code.

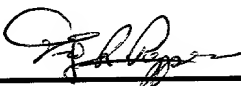
16. (Amended) The communication method according to claim 15, wherein said step of stopping the signal processing of the cell search includes the steps of:

generating a plurality of different codes,
generating a dummy code different from said generated code,
calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and
determining invalidity of the data based on a result of said calculation.

17. (Amended) A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
deleting multipath of the code already detected;
successively demodulating the received signals subjected to the deletion of the multipath with said detected spread codes; and
decoding said demodulated data.

REMARKS

The above amendments are being made to make amendments to the specification and claims prior to examination on the merits. The amendments do not add to or depart from the original disclosure, or constitute prohibited new matter.

RESPECTFULLY SUBMITTED,					
NAME AND REG. NUMBER	George R. Repper, Reg. No. 31,414				
SIGNATURE				DATE	September 12, 2001
Address	Rothwell, Figg, Ernst & Manbeck Suite 701-East, 555 13th Street, N.W.				
City	Washington	State	D.C.	Zip Code	20004
Country	U.S.A.	Telephone	202-783-6040	Fax	202-783-6031

Attachments: Marked-Up Copies of Amendments

SUBSTITUTE SPECIFICATION

Mobile Communication Terminal and Communication Method

5 Technical Field

[0001] The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

10

Background Art

[0002] In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems.

15

Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

20

[0003] Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

25

30

[0004] A stepwise search method has been known as a fast cell search method. Fig. 9 shows a processing procedure for detecting and deleting multipath components in the stepwise search method. First, slot timing for those including multipath components is detected (short-period detection) (S101). Detection of slots is performed by detecting search codes of the slots. By detecting the frame timing code, the frame timing is detected (long-period detection), and further the code group is detected (S102).

35

2017041629560

[0005] In addition to the code group, the candidate codes which belong to the group is further evaluated (S103), and finally a spread codes is identified. Information such as spread codes, which is required for recognizing the multipath, is stored in a memory 110 (S104). In this manner, the multipath is recognized based on the information of code and timing stored in memory 110, and the multipath is deleted from the obtained information (S105). The information, from which the multipath is deleted as described above, is decoded so that an amount of decode processing is reduced, and fast cell search can be achieved.

[0006] However, the multipath is deleted after all the slot timing, frame timing and codes for one slot are detected and stored in memory 110. This results in a problem that the time required for the entire cell search cannot be reduced.

[0007] The invention has been developed for overcoming the above problem, and a first object of the invention is to provide a mobile communication terminal allowing fast cell search.

[0008] A second object of the invention is to provide a mobile communication terminal allowing accurate identification of spread codes.

[0009] A third object of the invention is to provide a communication method allowing fast cell search.

[00010] A fourth object of the invention is to provide a communication method allowing precise identification of spread codes.

Disclosure of the Invention

[00011] According to an aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.

[00012] The control unit stops the signal processing of the cell search when invalid cell is received. Therefore, the cell search can be performed fast.

[00013] Preferably, the control unit determines the invalid cell based on the information received from the base station, and stops the processing of the cell.

[00014] Since the control unit stops the processing of the cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

[00015] The detector includes a slot timing detector detecting slot timing from the signals received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector from the signals received by the receiver, and a code detector detecting a code based on the slot timing detected by the slot timing detector and the code group detected by the code group detector from the signals received by the receiver.

[00016] The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

[00017] More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

[00018] Since the control unit stops the processing of received signals in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case where an unexisting code group is erroneously detected.

[00019] More preferably, the code group detector includes a plurality of code generators generating a code corresponding to a different code group, a dummy code generator generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators and a determining unit determining invalidity of the detected slot timing based on the calculation result of the plurality of correlators.

[00020] Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate code group.

[00021] More preferably, the control unit stops the signal processing of the cell search if the code detector detects the code group other than the code group including the predetermined code.

[00022] Since the control unit stops the signal processing of the cell search if the code detector detects the code other than the predetermined code, the processing of cell search can be performed fast even if an unexisting code is erroneously detected.

[00023] More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the

receiver and the codes generated by the plurality of code generators, and a determining unit determining invalidity of the detected slot timing based on the calculation result of the plurality of correlators.

5 **[00024]** Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

10 **[00025]** According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a plurality of search ranges, deleting multipath in the search range, successively allowing the demodulator to demodulate the received signals and allowing the decoder to decode the demodulated data.

15 **[00026]** The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

20 **[00027]** Preferably, the control unit stops the decode processing if the decoded data in the search range is invalid data.

25 **[00028]** Since the control portion stops the decode processing if the decoded data in the search range is invalid data, the time required for the cell search can be further reduced.

30 **[00029]** According to further another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the signal processing of the cell search if the demodulated data is invalid.

[00030] If the demodulated data is invalid, the signal processing of the cell search is stopped so that the cell search can be performed fast.

35 **[00031]** Preferably, the step of stopping the signal processing of the cell search includes the step of determining invalid cell based on the information received from the base station, and stopping the signal processing of the cell search.

[00032] Since the signal processing of the cell search is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

5 [00033] More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received signals, detecting a code group based on the detected slot timing from the received signals, and detecting a code based on the detected slot timing and the detected code group.

[00034] Since the code group and the code are detected based on the detected slot timing, the spread codes of each slot can be accurately identified.

10 [00035] More preferably, the step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code group received from the base station is not a code group including a predetermined code.

15 [00036] Since the signal processing of the cell search is stopped if the code group is not the code group including the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

20 [00037] More preferably, the step of stopping the signal processing of the cell search includes the steps of generating codes corresponding to a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining invalidity of the detected code group based on a result of the calculation.

25 [00038] Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

[00039] More preferably, the step of stopping the signal processing of the cell search includes the step of stopping the signal processing of the cell search if the code received from the base station is not a predetermined code.

30 [00040] If the code is different from the predetermined code, the signal processing of the cell search is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

35 [00041] More preferably, the step of stopping the signal processing of the cell search includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

[00042] Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

[00043] According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received signals subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

[00044] The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

[00045] Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

[00046] Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

Brief Description of the Drawings

[00047] Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

Fig. 2 is a block diagram showing schematic structures of a frame timing and code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

Fig. 7 shows determination of a multipath component;

Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

Fig. 9 is a flowchart showing recognition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

[00048] The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

5 [00049] Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts
10 received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by
15 demodulator 8, and a memory 10 which stores a program to be executed by microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

[00050] Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code
20 generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a
25 high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

[00051] Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not
30 generate the codes for detecting the code group, but generate the codes for detecting the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

[00052] Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the

digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

[00053] Then, microcomputer 4 determines whether the frame timing and code group detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

[00054] Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

[00055] According to the mobile communication terminal of this embodiment, as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

(Second Embodiment)

[00056] A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

[00057] Fig. 4 is a block diagram showing a schematic structure of frame timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the digital signals sent from A/D converter 3 and the codes output from code

generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

5 **[00058]** Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes generated by code generators 1 - M (15-1 - 15-M).

10 **[00059]** If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

15 **[00060]** In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

20 **[00061]** Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

25 **[00062]** Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

[00063] If code generators $M+1 - N$ ($19-(M+1) - 19-N$) generating the dummy codes were not employed, determination would be performed to identify the one among code generators $1 - M$ ($19-1 - 19-M$), which generated the code exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators $1 - M$ ($19-1 - 19-M$), one of them would be detected as the code, and this detection would be error in many cases.

[00064] In contrast to the above, code generators $M+1 - N$ ($19-1 - 19-N$) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators $M+1 - N$ ($19-(M+1) - 19-N$) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

[00065] According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

(Third Embodiment)

[00066] A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

[00067] Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

[00068] When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as described above.

[00069] Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine

the correlation between the received data in a search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

[00070] Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if is detected (S16).

[00071] Fig. 7 shows detection of the multipath. When the slot indicated by shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m: time of search operations).

[00072] As indicated by in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C₃" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C₇" and "C₂" so that these are determined as carrier waves coming from different base stations, respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

[00073] Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

[00074] Microcomputer 4 performs the processing of determining validity/invalidity of the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the

processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

[00075] The processing in steps S13 - S19 described above are performed for $i = 0 - n'-1$, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

[00076] According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for deleting the multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

[00077] Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

CLAIMS

1. A mobile communication terminal comprising:
a receiver (2) receiving a radio wave from base stations;
5 a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2);
a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);
a decoder (9) decoding data demodulated by said demodulator (8); and
10 a control unit (4) controlling cell search process, and stopping signal processing of the cell search in response to detection of invalid cell.

2. The mobile communication terminal according to claim 1, wherein
said control unit (4) determines the invalid cell based on information received
15 from the base station, and stops the processing of said cell.

3. The mobile communication terminal according to claim 2, wherein
said detector (5, 6, 7) includes:
a slot timing detector (5) detecting slot timing from the signals received by said
20 receiver (2),
a code group detector (6) detecting a code group based on the slot timing detected by said slot timing detector (5) from the signals received by said receiver (2),
and
a code detector (7) detecting a code based on the slot timing detected by said
25 slot timing detector (5) and the code group detected by said code group detector from the signals received by said receiver (2).

4. The mobile communication terminal according to claim 3, wherein
said control unit (4) stops the processing of received signals when the code
30 group detected by said code group detector (6) is not a predetermined code.

5. The mobile communication terminal according to claim 4, wherein
said code group detector (6) includes:
a plurality of code generators (15-1 - 15-N), each of said code generators (15-1
35 - 15-M) generating a code corresponding to a different code group,
a dummy code generator (15-(M+1) - 15-N) generating a dummy code different from the code groups generated by said plurality of code generators (15-1 - 15-M),

a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 - 16-N) calculating correlation between the signal received by said receiver (2) and the code generated by the corresponding code generator (15-1 - 15-N), and
a determining unit (18) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (16-1 - 16-N).

6. The mobile communication terminal according to claim 3, wherein
said control unit (4) stops the signal processing of the cell search if the code detector (7) detects a code group other than a code group including the predetermined code.

7. The mobile communication terminal according to claim 6, wherein
said code detector (7) includes:
a plurality of code generators (19-1 - 19-N), each of said code generators (19-1 - 19-M) generating a different code,
a dummy code generator (19-(M+1) - 19-N) generating a dummy code different from the codes generated by said plurality of code generators (19-1 - 19-M),
a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N), and
a determining unit (22) determining invalidity of the detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. A mobile communication terminal comprising:
a receiver (2) receiving a radio wave from base stations;
a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),
a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);
a decoder (9) decoding data demodulated by said demodulator (8); and
a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range, successively allowing said demodulator (8) to demodulate the received signals and allowing said decoder (9) to decode the demodulated data.

9. The mobile communication terminal according to claim 8, wherein

said control unit (4) stops the decode processing if the decoded data in said search range is invalid data.

5 10. A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
demodulating the received signals with said detected spread codes;
decoding said demodulated data; and
controlling cell search process, and stopping signal processing of the cell search
10 if said demodulated data is invalid cell.

15 11. The communication method according to claim 10, wherein
said step of stopping the signal processing of the cell search includes the step of
determining invalid cell based on information received from the base station, and
stopping the signal processing of the cell search.

20 12. The communication method according to claim 11, wherein
said step of detecting the spread codes includes the steps of:
detecting slot timing from said received signals,
detecting a code group based on said detected slot timing from said received
signals, and
detecting a code based on said detected slot timing and said detected code
group.

25 13. The communication method according to claim 12, wherein
said step of stopping the signal processing of the cell search includes the step of
stopping the signal processing of the cell search if the code group received from the
base station is not a code group including a predetermined code.

30 14. The communication method according to claim 13, wherein
said step of stopping the signal processing of the cell search includes the steps
of:

35 generating codes corresponding to a plurality of different code groups,
generating a dummy code different from said plurality of generated code
groups,
calculating correlations of said received signals with respect to said plurality of
generated code and the dummy code, and

determining invalidity of the detected code group based on a result of said calculation.

5 15. The communication method according to claim 12, wherein
said step of stopping the signal processing of the cell search includes the step of
stopping the signal processing of the cell search if the code received from the base
station is not a predetermined code.

10 16. The communication method according to claim 15, wherein
said step of stopping the signal processing of the cell search includes the steps
of:
generating a plurality of different codes,
generating a dummy code different from said generated code,
calculating correlations of said received signals with respect to said plurality of
15 generated codes and said dummy code, and
determining invalidity of the data based on a result of said calculation.

20 17. A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
deleting multipath of the code already detected;
successively demodulating the received signals subjected to the deletion of the
multipath with said detected spread codes; and
decoding said demodulated data.

25 18. The communication method according to claim 17, wherein
said decoding processing is not performed in said step of deleting the multipath
if the newly detected code is the multipath.

ABSTRACT

5 A mobile communication terminal includes a receiver (2) receiving a radio
wave from base stations, a detector (5, 6, 7) detecting spread codes from the signal
received by the receiver (2), a demodulator (8) demodulating the received signal with
the spread codes detected by the detector (5, 6, 7), a decoder (9) decoding data
demodulated by the demodulator (8), and a control unit (4) controlling processing
during cell search, and stopping processing of the data in response to reception of
invalid data. Since the control unit (4) stops the processing of the data if it receives the
10 invalid data, the cell search can be performed fast.

Marked-up Copy of Amended Specification

SPECIFICATION

Mobile Communication Terminal and Communication Method

5 Technical Field

The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

10 Background Art

In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems. Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

A stepwise search method has been known as a fast cell search method. Fig. 9 shows a processing procedure for detecting and deleting multipath components in the stepwise search method. First, slot timing for those including multipath components is detected (short-period detection) (S101). Detection of slots is performed by detecting search codes of the slots. By detecting the frame timing code, the frame timing is

Marked-up Copy of Amended Specification

detected (long-period detection), and further the code group is detected (S102).

In addition to the code group, the candidate codes which belong to the group is further evaluated (S103), and finally a spread codes is identified. Information such as spread codes, which is required for recognizing the multipath, is stored in a memory
5 110 (S104). In this manner, the multipath is recognized based on the information of code and timing stored in memory 110, and the multipath is deleted from the obtained information (S105). The information, from which the multipath is deleted as described above, is decoded so that an amount of decode processing is reduced, and fast cell search can be achieved.

10 However, the multipath is deleted after all the slot timing, frame timing and codes for one slot are detected and stored in memory 110. This results in a problem that the time required for the entire cell search cannot be reduced.

The invention has been developed for overcoming the above problem, and a first object of the invention is to provide a mobile communication terminal allowing
15 fast cell search.

A second object of the invention is to provide a mobile communication terminal allowing accurate identification of spread codes.

A third object of the invention is to provide a communication method allowing fast cell search.

20 A fourth object of the invention is to provide a communication method allowing precise identification of spread codes.

Disclosure of the Invention

According to an aspect of the invention, a mobile communication terminal
25 includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and stopping signal processing of the cell search in response to detection of
30 invalid [data] cell.

The control unit stops the signal processing of the cell search when invalid [data] cell is received. Therefore, the cell search can be performed fast.

Preferably, the control unit determines the invalid [data] cell based on the

Marked-up Copy of Amended Specification

information received from the base station, and stops the processing of the [data] cell.

Since the control unit stops the processing of the [data] cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

5 The detector includes a slot timing detector detecting slot timing from the [data] signals received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector from the signals received by the receiver, and a code detector detecting a code based on the slot timing detected by the slot timing detector and the code group detected by the code group detector from the
10 signals received by the receiver.

The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

15 More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

Since the control [portion] unit stops the processing of received [data] signals in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case
20 where an unexisting code group is erroneously detected.

More preferably, the code group detector includes a plurality of code generators generating a code corresponding to a different code group, a dummy code generator generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data
25 received by the receiver and the codes generated by the plurality of code generators and a determining unit determining invalidity of [data] the detected slot timing based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate
30 code group.

More preferably, the control unit stops the signal processing of the [received data] cell search if the code detector detects the code group other than the code group including the predetermined code.

Marked-up Copy of Amended Specification

Since the control unit stops the signal processing of the [received data] cell search if the code detector detects the code other than the predetermined code, the processing of cell search can be performed fast even if an unexisting code is erroneously detected.

5 More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators, and a determining unit determining
10 invalidity of the [data] detected slot timing based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

15 According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a plurality of search ranges, deleting multipath in the search range [and], successively [decoding
20 the received data by the decoder] allowing the demodulator to demodulate the received signals and allowing the decoder to decode the demodulated data.

The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the
25 cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

Preferably, the control unit stops the decode processing if the [received] decoded data in the search range is invalid data.

30 Since the control portion stops the decode processing if the [received] decoded data in the search range is invalid data, the time required for the cell search can be further reduced.

According to further another aspect of the invention, a communication method

Marked-up Copy of Amended Specification

includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the signal processing of the cell search if the [received] demodulated data is invalid.

If the [received] demodulated data is invalid, the signal processing of the [received data] cell search is stopped so that the cell search can be performed fast.

Preferably, the step of stopping the signal processing of the [received data] cell search includes the step of determining invalid [data] cell based on the information received from the base station, and stopping the signal processing of the [data] cell search.

Since the signal processing of the [data] cell search is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received [data] signals, detecting a code group based on the detected slot timing from the received signals, and detecting a code based on the detected slot timing and the detected code group.

Since the code group and the code are detected based on the detected slot timing, the spread codes of each slot can be accurately identified.

More preferably, the step of stopping the [data] signal processing of the cell search includes the step of stopping the signal processing of the [received data] cell search if the code group received from the base station is not a code group including a predetermined code.

Since the signal processing of the [received data] cell search is stopped if the code group is not the code group including the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

More preferably, the step of stopping the signal processing of the [received data] cell search includes the steps of generating codes corresponding to a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining

Marked-up Copy of Amended Specification

invalidity of the [data] detected code group based on a result of the calculation.

Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

5 More preferably, the step of stopping the signal processing of the [data] cell search includes the step of stopping the signal processing of the [received data] cell search if the code received from the base station is not a predetermined code.

If the code is different from the predetermined code, the signal processing of the [received data] cell search is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

10 More preferably, the step of stopping the [data] signal processing of the cell search includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

15 Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

20 According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received [data] signals subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

25 Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

30 Brief Description of the Drawings

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

Fig. 2 is a block diagram showing schematic structures of a frame timing and

Marked-up Copy of Amended Specification

code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

5 Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

10 Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

Fig. 7 shows determination of a multipath component;

Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

15 Fig. 9 is a flowchart showing recognition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

20 The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak
25 radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects
30 frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by demodulator 8, and a memory 10 which stores a program to be executed by

microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code
5 generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a
10 high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not generate the codes for detecting the code group, but generate the codes for detecting
15 the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing
20 detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

Then, microcomputer 4 determines whether the frame timing and code group
25 detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing
30 and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code

exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

According to the mobile communication terminal of this embodiment, as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

(Second Embodiment)

A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

Fig. 4 is a block diagram showing a schematic structure of frame timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the digital signals sent from A/D converter 3 and the codes output from code generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes

generated by code generators 1 - M (15-1 - 15-M).

If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

If code generators M+1 - N (19-(M+1) - 19-N) generating the dummy codes were not employed, determination would be performed to identify the one among code generators 1 - M (19-1 - 19-M), which generated the code exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the

code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators 1 - M (19-1 - 19-M), one of them would be detected as the code, and this detection would be error in many cases.

5 In contrast to the above, code generators M+1 - N (19-1 - 19-N) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators M+1 - N (19-(M+1) - 19-N) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

10 According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

15 (Third Embodiment)

A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

20 Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

25 When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as described above.

30 Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine the correlation between the received data in a search range j of the slot and the code

Marked-up Copy of Amended Specification

groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if is detected (S16).

Fig. 7 shows detection of the multipath. When the slot indicated by shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m: time of search operations).

As indicated by in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C₃" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C₇" and "C₂" so that these are determined as carrier waves coming from different base stations, respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

Microcomputer 4 performs the processing of determining validity/invalidity of

Marked-up Copy of Amended Specification

the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by
5 frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

10 The processing in steps S13 - S19 described above are performed for $i = 0 - n' - 1$, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

15 According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for deleting the
20 multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

25 Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Marked-up Copy of Amended Claims

CLAIMS

1. (Amended) A mobile communication terminal comprising:
a receiver (2) receiving a radio wave from base stations;
5 a detector (5, 6, 7) detecting spread codes from signals received by
said receiver (2);
a demodulator (8) demodulating the received signals with the spread
codes detected by said detector (5, 6, 7);
a decoder (9) decoding data demodulated by said demodulator (8);
10 and
a control unit (4) controlling cell search process, and stopping signal
processing of the cell search in response to detection of invalid [data] cell.
2. (Amended) The mobile communication terminal according to
15 claim 1, wherein
said control unit (4) determines the invalid [data] cell based on
information received from the base station, and stops the processing of said
[data] cell.
- 20 3. (Amended) The mobile communication terminal according to
claim 2, wherein
said detector (5, 6, 7) includes:
a slot timing detector (5) detecting slot timing from the signals
received by said receiver (2),
25 a code group detector (6) detecting a code group based on the slot
timing detected by said slot timing detector (5) from the signals received by
said receiver (2), and
a code detector (7) detecting a code based on the slot timing detected
by said slot timing detector (5) and the code group detected by said code
30 group detector from the signals received by said receiver (2).
4. (Amended) The mobile communication terminal according to
claim 3, wherein

Marked-up Copy of Amended Claims

said control unit (4) stops the processing of received [data] signals when the code group detected by said code group detector (6) is not a predetermined code.

- 5 5. (Amended) The mobile communication terminal according to claim 4, wherein
said code group detector (6) includes:
a plurality of code generators (15-1 - 15-N), each of said code
generators (15-1 - 15-M) generating a code corresponding to a different code
10 group,
a dummy code generator (15-(M+1) - 15-N) generating a dummy code
different from the code groups generated by said plurality of code
generators (15-1 - 15-M),
a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 -
15 16-N) calculating correlation between the signal received by said receiver
(2) and the code generated by the corresponding code generator (15-1 - 15-
N), and
a determining unit (18) determining invalidity of the [data] detected
slot timing based on the calculation result of said plurality of correlators
20 (16-1 - 16-N).

6. (Amended) The mobile communication terminal according to
claim 3, wherein
said control unit (4) stops the signal processing of the [received data]
25 cell search if the code detector (7) detects a code group other than a code
group including the predetermined code.

7. (Amended) The mobile communication terminal according to
claim 6, wherein
30 said code detector (7) includes:
a plurality of code generators (19-1 - 19-N), each of said code
generators (19-1 - 19-M) generating a different code,
a dummy code generator (19-(M+1) - 19-N) generating a dummy code

Marked-up Copy of Amended Claims

different from the codes generated by said plurality of code generators (19-1 - 19-M),

a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 - 20-N) calculating correlation between the data received by said receiver (2) and the code generated by the corresponding code generator (19-1 - 19-N),
and

a determining unit (22) determining invalidity of the [data] detected slot timing based on the calculation result of said plurality of correlators (20-1 - 20-N).

8. (Amended) A mobile communication terminal comprising:

a receiver (2) receiving a radio wave from base stations;

a detector (5, 6, 7) detecting spread codes from signals received by said receiver (2),

a demodulator (8) demodulating the received signals with the spread codes detected by said detector (5, 6, 7);

a decoder (9) decoding data demodulated by said demodulator (8);

and

a control unit (4) dividing a slot into a plurality of search ranges, deleting multipath in said search range [and], successively [decoding the received data by said decoder (9)] allowing said demodulator (8) to demodulate the received signals and allowing said decoder (9) to decode the demodulated data.

9. (Amended) The mobile communication terminal according to claim 8, wherein

said control unit (4) stops the decode processing if the [received] decoded data in said search range is invalid data.

10. (Amended) A communication method comprising the steps of:
receiving a radio wave from base stations;

detecting spread codes from said received signals;

demodulating the received signals with said detected spread codes;

Marked-up Copy of Amended Claims

decoding said demodulated data; and
controlling cell search process, and stopping signal processing of the
cell search if said [received] demodulated data is invalid cell.

5 11. (Amended) The communication method according to claim 10,
wherein
said step of stopping the signal processing of the cell search includes
the step of determining invalid [data] cell based on information received
from the base station, and stopping the signal processing of the [data] cell
10 search.

12. (Amended) The communication method according to claim 11,
wherein
said step of detecting the spread codes includes the steps of:
15 detecting slot timing from said received signals,
detecting a code group based on said detected slot timing from said
received signals, and
detecting a code based on said detected slot timing and said detected
code group.

20 13. (Amended) The communication method according to claim 12,
wherein
said step of stopping the signal processing of [said received data] the
cell search includes the step of stopping the signal processing of the cell
25 search if the code group received from the base station is not a code group
including a predetermined code.

14. (Amended) The communication method according to claim 13,
wherein
30 said step of stopping the signal processing of the cell search includes
the steps of:
generating codes corresponding to a plurality of different code
groups,

Marked-up Copy of Amended Claims

generating a dummy code different from said plurality of generated code groups,

calculating correlations of said received signals with respect to said plurality of generated code and the dummy code, and

5 determining invalidity of the [data] detected code group based on a result of said calculation.

15. (Amended) The communication method according to claim 12, wherein

10 said step of stopping the signal processing of [said received data] the cell search includes the step of stopping the signal processing of the [received data] cell search if the code received from the base station is not a predetermined code.

15 16. (Amended) The communication method according to claim 15, wherein

said step of stopping the signal processing of [said received data] the cell search includes the steps of:

generating a plurality of different codes,

20 generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and

determining invalidity of the data based on a result of said calculation.

25 17. (Amended) A communication method comprising the steps of:
receiving a radio wave from base stations;

detecting spread codes from said received signals;

deleting multipath of the code already detected;

30 successively demodulating the received [data] signals subjected to the deletion of the multipath with said detected spread codes; and
decoding said demodulated data.

9/1/85

09/936294

JC03 Rec'd PGT/PTO 12 SEP 2001

SPECIFICATION

Mobile Communication Terminal and Communication Method

5 Technical Field

The present invention relates to a mobile communication terminal employing a code division multiplex method for communication, and particularly a mobile communication terminal which rapidly searches adjacent cells during cell search.

10

Background Art

In recent years, mobile communication terminals such as a portable telephone and a mobile telephone have been widely used, and various kinds of multiple access methods have been developed for use in such mobile communication systems. Among them, a CDMA (Code Division Multiple Access) method has been employed in portable telephones and others because it has high quality reception capability through the exploitation of multipath fading, and can achieve a high utilization efficiency of radio resource (can increase a subscriber capacity).

15

20

25

30

Fig. 8 is a schema which shows that the mobile station can receive a number of radio waves transmitted from adjacent cells via multiple propagation paths (multipath). In general, a plurality of base stations (BS1 - BS5) are arranged regularly, and cells of the base stations form a regular polygon if these base stations are arranged to cover a service area with as high a electric field as possible, as is well known and shown in Fig. 8. When a mobile communication terminal (MS) performs the cell search, it receives a plurality of radio waves from respective base stations, and additionally receives radio waves (multipath), which are transmitted from various base stations, and are shifted in timing from each other due to wave reflection and diffraction. This multipath is not necessary, and therefore is deleted during the cell search operation by an appropriate manner.

A stepwise search method has been known as a fast cell search

09/936294, 031103

9/8/85

method. Fig. 9 shows a processing procedure for detecting and deleting
multipath components in the stepwise search method. First, slot timing
for those including multipath components is detected (short-period
detection) (S101). Detection of slots is performed by detecting search
5 codes of the slots. By detecting the frame timing code, the frame timing is
detected (long-period detection), and further the code group is detected
(S102).

In addition to the code group, the candidate codes which belong to
the group is further evaluated (S103), and finally a spread codes is
10 identified. Information such as spread codes, which is required for
recognizing the multipath, is stored in a memory 110 (S104). In this
manner, the multipath is recognized based on the information of code and
timing stored in memory 110, and the multipath is deleted from the
obtained information (S105). The information, from which the multipath
15 is deleted as described above, is decoded so that an amount of decode
processing is reduced, and fast cell search can be achieved.

However, the multipath is deleted after all the slot timing, frame
timing and codes for one slot are detected and stored in memory 110. This
results in a problem that the time required for the entire cell search cannot
20 be reduced.

The invention has been developed for overcoming the above problem,
and a first object of the invention is to provide a mobile communication
terminal allowing fast cell search.

A second object of the invention is to provide a mobile
25 communication terminal allowing accurate identification of spread codes.

A third object of the invention is to provide a communication method
allowing fast cell search.

A fourth object of the invention is to provide a communication
method allowing precise identification of spread codes.

30

Disclosure of the Invention

According to an aspect of the invention, a mobile communication
terminal includes a receiver receiving a radio wave from base stations; a

201 FEB 04 16:29:55 09936294 031100
detector detecting spread codes from signals received by the receiver; a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit controlling cell search process, and
5 stopping processing of the cell search in response to detection of invalid data.

The control unit stops the processing of the cell search when invalid data is received. Therefore, the cell search can be performed fast.

10 Preferably, the control unit determines the invalid data based on the information received from the base station, and stops the processing of the data.

15 Since the control unit stops the processing of the data cell based on the information received from the base station, the cell search can be performed fast even in the cases, e.g., of erroneous detection of an unexisting code or frame timing.

20 The detector includes a slot timing detector detecting slot timing from the data received by the receiver, a code group detector detecting a code group based on the slot timing detected by the slot timing detector, and a code detector detecting a code based on the slot timing detected by the slot timing detector.

The code group detector and the code detector detect the code group and the code based on the slot timing detected by the slot timing detector, respectively. Therefore, the identification of the spread codes of each slot can be accurately performed.

25 More preferably, the control portion stops the processing of received data when the code group detected by the code group detector is not a predetermined code.

30 Since the control portion stops the processing of received data in the case where the code group detected by the code group detector is not the predetermined code, the cell search processing can be performed fast even in the case where an unexisting code group is erroneously detected.

More preferably, the code group detector includes a plurality of code generators generating a different code group, a dummy code generator

generating a dummy code different from the code group generated by the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators and a determining unit
5 determining invalidity of data based on the calculation result of the plurality of correlators.

Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, it is possible to detect an inappropriate code group.

10 More preferably, the control unit stops the processing of the received data if the code detector detects the code other than the predetermined code.

Since the control unit stops the processing of the received data if the code detector detects the code other than the predetermined code, the
15 processing of cell search can be performed fast even if an unexisting code is erroneously detected.

More preferably, the code detector includes a plurality of code generators generating different codes, respectively, a dummy code generator generating a dummy code different from the codes generated by
20 the plurality of code generators, a plurality of correlators calculating correlations between the data received by the receiver and the codes generated by the plurality of code generators, and a determining unit determining invalidity of the data based on the calculation result of the plurality of correlators.

25 Since the correlators calculate the correlation between the received data and the code generated by the dummy code generator, an inappropriate code can be detected.

According to another aspect of the invention, a mobile communication terminal includes a receiver receiving a radio wave from
30 base stations; a detector detecting spread codes from signals received by the receiver, a demodulator demodulating the received signals with the spread codes detected by the detector; a decoder decoding data demodulated by the demodulator; and a control unit dividing a slot into a

plurality of search ranges, deleting multipath in the search range and successively decoding the received data by the decoder.

5 The control unit divides the slot into a plurality of search ranges, deletes the multipath in the search range, and allows the decoder to decode successively the received data. Therefore, the data processing by the decoder can be reduced, and the cell search processing can be performed fast. Further, the detector, demodulator, decoder and control portion can be operated in parallel to perform pipeline processing so that the processing speed can be further increased.

10 Preferably, the control unit stops the decode processing if the received data in the search range is invalid data.

Since the control portion stops the decode processing if the received data in the search range is invalid data, the time required for the cell search can be further reduced.

15 According to further another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations; detecting spread codes from the received signals; demodulating the received signals with the detected spread codes; decoding the demodulated data; and controlling a cell search process, and stopping the processing of the cell search if the received data is invalid.

20 If the received data is invalid, the processing of the received data is stopped so that the cell search can be performed fast.

25 Preferably, the step of stopping the processing of the received data includes the step of determining invalid data based on the information received from the base station, and stopping the processing of the data.

Since the processing of the data is stopped based on the information received from the base station, the cell search can be performed fast, for example, even in the case where an unexisting code is detected.

30 More preferably, the step of detecting the spread codes includes the steps of detecting slot timing from the received data, detecting a code group based on the detected slot timing, and detecting a code based on the detected slot timing.

Since the code group and the code are detected based on the detected

slot timing, the spread codes of each slot can be accurately identified.

More preferably, the step of stopping the data processing includes the step of stopping the processing of the received data if the code group received from the base station is not a predetermined code.

5 Since the processing of the received data is stopped if the code group is not the predetermined code, the processing of cell search can be performed further fast if inappropriate data is received from the base station.

10 More preferably, the step of stopping the processing of the received data includes the steps of generating a plurality of different code groups, respectively, generating a dummy code different from the plurality of generated code groups, calculating the correlation of the received data with respect to the plurality of generated code and the dummy code, and determining invalidity of the data based on a result of the calculation.

15 Since the correlation between the received data and the generated code is calculated, an inappropriate code group can be detected.

More preferably, the step of stopping the processing of the data includes the step of stopping the processing of the received data if the code received from the base station is not a predetermined code.

20 If the code is different from the predetermined code, the processing of the received data is stopped so that the cell search processing can be performed further fast even if an unexisting code group is erroneously detected.

25 More preferably, the step of stopping the data processing includes the steps of generating a plurality of different codes, generating a dummy code different from the generated code, calculating a correlation of the received data with respect to the plurality of generated codes and the dummy code, and determining invalidity of the data based on a result of the calculation.

30 Since the correlation between the received data and the generated code is calculated, an inappropriate code can be detected.

According to still another aspect of the invention, a communication method includes the steps of receiving a radio wave from base stations;

detecting spread codes from the received signals; deleting multipath of the code already detected; successively demodulating the received data subjected to the deletion of the multipath with the detected spread codes; and decoding the demodulated data.

5 The multipath of the code already detected is deleted, and the received data is successively demodulated and decoded. Therefore, the decode processing can be eliminated, and the processing of cell search can be performed fast.

10 Preferably, the decoding processing is not performed in the step of deleting the multipath if the newly detected code is the multipath.

 Since the decode processing is not performed if the newly detected code is the multipath, the time required for the cell search can be further reduced.

15 Brief Description of the Drawings

 Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention;

20 Fig. 2 is a block diagram showing schematic structures of a frame timing and code group detector 6 and a code detector 7 of the mobile communication terminal of the first embodiment of the invention;

 Fig. 3 is a flowchart for showing a processing procedure of the mobile communication terminal of the first embodiment of the invention;

25 Fig. 4 is a block diagram showing a schematic structure of a frame timing and code group detector 6' of a mobile communication terminal of a second embodiment of the invention;

 Fig. 5 is a block diagram showing a schematic structure of a code detector 7' of the mobile communication terminal of the second embodiment of the invention;

30 Fig. 6 is a flowchart showing a processing procedure of a mobile communication terminal of a third embodiment of the invention;

 Fig. 7 shows determination of a multipath component;

 Fig. 8 shows that MS receives radio waves which include multipath components from adjacent cells;

Fig. 9 is a flowchart showing recognition and deletion of the multipath component during cell search in the prior art.

Best Mode for Carrying Out the Invention

5 The invention will now be described in greater detail with reference to the drawings.

(First Embodiment)

10 Fig. 1 is a block diagram showing a schematic structure of a mobile communication terminal of a first embodiment of the invention. This mobile communication terminal includes an antenna 1, a receiver 2 which receives a weak radio frequency wave sent from base stations via antenna 1 and down-converts that into a baseband frequency wave, an A/D (Analog-to-Digital) converter 3 which converts received analog signals into digital signals, a microcomputer 4 which performs entire control of the mobile communication terminal, a slot timing detector 5 for detecting slot timing during cell search, a frame timing and code group detector 6 which detects frame timing and code group during cell search, a code detector 7 which detects a code during cell search, a demodulator 8 which demodulates a received code with a detected spread codes, a decoder 9 which decodes the received signals demodulated by demodulator 8, and a memory 10 which stores a program to be executed by microcomputer 4 and others. The detection of the frame timing may be performed by code detector 7.

20 Fig. 2 is a block diagram showing a schematic structure of frame timing and code group detector 6. Frame timing and code group detector 6 includes code generators 1 - N (11-1 - 11-N) generating codes, which are used when detecting a code group, correlators 1 - N (12-1 - 12-N) which calculates correlations between a digital signal sent from A/D converter 3 and the codes generated by code generators 1 - N (11-1 - 11-N), a comparator 13 comparing correlation values output from correlators 1 - N (12-1 - 12-N), and a determining unit 14 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 13. The result of determination of determining unit 14 is stored in memory 10.

Code detector 7 has a structure similar to that of frame timing and code group detector 6 shown in Fig. 2. However, code generators 1 - N (11-1 - 11-N) do not generate the codes for detecting the code group, but generate the codes for detecting the codes so that correlators 1 - N (12-1 - 12-N) calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (11-1 - 11-N).

Fig. 3 is a flowchart showing a processing procedure of the mobile communication terminal of the first embodiment of the invention. First, slot timing detector 5 receives the digital signal sent from A/D converter 3, and detects the slot timing (S1). Frame timing and code group detector 7 detects the frame timing from the digital signal sent from A/D converter 3 using the frame timing code, and detects the code group based on the slot timing detected by slot timing detector 5 (S2).

Then, microcomputer 4 determines whether the frame timing and code group detected by frame timing and code group detector 6 are valid or not (S3). For example, it is determined that the code group is invalid if there is no code group exhibiting a high correlation, as will be described later in connection with a second embodiment. If it is determined that the frame timing or code group is invalid (invalid in S3), microcomputer 4 ends the processing as it is. If it is determined that the frame timing and code group are valid (valid in S3), microcomputer 4 operates to detect the code by code detector 7 (S4).

Then, microcomputer 4 determines whether the code detected by code detector 7 is valid or not (S5). For example, it is determined that the code is invalid if the code exhibiting a high correlations is not present, as will be described later in connection with the second embodiment. When it is determined that the code is invalid (invalid in S4), microcomputer 4 stops the processing as it is. When it is determined that the code is valid (valid in S4), microcomputer 4 stores the code in memory 10. The multipath is detected and deleted from the code stored in memory 10 (S7). Decoder 9 decodes the data demodulated by demodulator 8 to acquire the notification information, and the processing ends.

According to the mobile communication terminal of this embodiment,

as described above, the information is not stored, and the processing stops if the frame timing, code group or code is invalid. Therefore, the detection of the multipath during the cell search can be efficiently performed, and the processing speed can be improved.

5 (Second Embodiment)

A mobile communication terminal of a second embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the structures of the frame timing and code group detector and the code detector as well as the program to be
10 executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated. In the second embodiment, the frame timing and code group detector and the code detector bear the reference numbers 6' and 7', respectively.

Fig. 4 is a block diagram showing a schematic structure of frame
15 timing and code group detector 6' of the second embodiment. Frame timing and code group detector 6' includes code generators 1 - M (15-1 - 15-M) generating codes for detecting the frame timing and the code group, code generators M+1 - N (15-(M+1) - 15-N) generating dummy codes, correlators 1 - N (16-1 - 16-N) which calculate correlations between the
20 digital signals sent from A/D converter 3 and the codes output from code generators 1 - N (15-1 - 15-N), a comparator 17 which compares correlation values output from correlators 1 - N (16-1 - 16-N), and a determining unit 18 which determines a code group exhibiting a high correlation based on the result of comparison by comparator 17.

25 Code generators 1 - M (15-1 - 15-M) generate codes for detecting the original frame timing code and code group. Meanwhile code generators M+1 - N (15-(M+1) - 15-N) are employed for generating codes for detecting the frame timing code and dummy code group, and thus generate the dummy codes different from the codes generated by code generators 1 - M
30 (15-1 - 15-M).

If code generators M+1 - N (15-(M+1) - 15-N) generating the dummy code group were not employed, determination would be performed to identify the one among code generators 1 - M (15-1 - 15-M), which

generated the frame timing code and the code group exhibiting the highest correlation with respect to the digital signal sent from A/D converter 3, and thereby the code group would be detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the code groups generated by code generators 1 - M (15-1 - 15-M), one of them would be detected as the code group, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (15-(M+1) - 15-N) generate the frame timing codes and the dummy codes, and calculation is performed to determine the correlation of the received code with respect to the frame timing codes and the dummy code group generated by code generators M+1 - N (15-(M+1) - 15-N). When the result exhibits the highest correlation, it is determined that any code group is not detected so that erroneous detection of the code group is prevented.

Fig. 5 is a block diagram showing a schematic structure of code detector 7'. Code detector 7' includes code generators 1 - N (19-1 - 19-M) which generate codes for detecting the codes, code generators M+1 - N (19-(M+1) - 19-N) which generates dummy codes, correlators 1 - N (20-1 - 20-N) which calculate the correlations between the digital signal sent from A/D converter 3 and the codes output from code generators 1 - N (19-1 - 19-N), a comparator 21 which compares the correlation values output from correlators 1 - N (20-1 - 20-N), and a determining unit 22 which determines a code exhibiting a high correlation based on the result of comparison by comparator 21.

Code generators 1 - M (19-1 - 19-M) generate the codes for detecting original codes. Meanwhile, code generators M+1 - N (19-(M+1) - 19-N) are employed for generating the codes for detecting the dummy code, and are configured to generate the dummy codes, which are different from the codes generated by code generators 1 - M (19-1 - 19-M).

If code generators M+1 - N (19-(M+1) - 19-N) generating the dummy codes were not employed, determination would be performed to identify the one among code generators 1 - M (19-1 - 19-M), which generated the code exhibiting the highest correlation with respect to the digital signal sent

from A/D converter 3, and thereby the code is detected. In this case, however, even if the digital signal sent from A/D converter 3 exhibited a low correlation with respect to each of the codes generated by code generators 1 - M (19-1 - 19-M), one of them would be detected as the code, and this detection would be error in many cases.

In contrast to the above, code generators M+1 - N (19-1 - 19-N) generate the frame timing codes and the codes. In the case where the highest correlation is present between the dummy code generated by code generators M+1 - N (19-(M+1) - 19-N) and the received code, it is determined that the code is not received so that erroneous detection of the code is prevented.

According to the mobile communication terminal of this embodiment, as described above, the code generators generate the dummy code group or dummy codes, and detection of the code group or code is not performed if the received code exhibits a high correlation with respect to the dummy code group or the dummy code. Therefore, erroneous detection of the code group or code can be prevented.

(Third Embodiment)

A mobile communication terminal of a third embodiment of the invention differs from the mobile communication terminal of the first embodiment shown in Fig. 1 only in the program to be executed by microcomputer 4. Accordingly, description of the structures and functions similar to those of the first embodiment is not repeated.

Fig. 6 is a flowchart showing a processing procedure of the mobile communication terminal of the third embodiment. In this flowchart, m indicates a number of operations of searching the slot, and n' indicates the number of paths detected in a step S12. For example, if one slot is searched by four divided operations, m is equal to 4, and n' represents the number of paths detected in this processing.

When microcomputer 4 instructs slot timing detector 5 to detect the slot timing (S11), slot timing detector 5 detects the search code of the slot, and thereby detects the slot timing applied from each base station (S12). The number of paths detected in this processing is represented by n' as

described above.

Then, microcomputer 4 instructs detection of the frame timing and identification of the spread codes to frame timing and code group detector 6 and code detector 7 (S13). When frame timing and code group detector 6 receives the instruction for identification of the spread codes, calculation is performed to determine the correlation between the received data in a search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code group is detected (S14). When code detector 7 receives the instruction for identification of the spread codes, the calculation is performed to determine the correlation between the received data in the search range j of the slot and the code groups generated by code generators 1 - N, and thereby the code is detected (S15).

Microcomputer 4 discriminates between the multipath and the paths sent from different base stations based on the spread codes, which is identified by frame timing and code group detector 6 and code detector 7, and deletes the multipath if it is detected (S16).

Fig. 7 shows detection of the multipath. When the slot indicated by ① shown in Fig. 7 is received, slot timing of each of slots, which are multiplexed in one slot, is detected (S12 in Fig. 6). As indicated by ② in Fig. 7, the frame timing and code group are detected (S14 in Fig. 6). As indicated by ③ in Fig. 7, the code is detected (S15 in Fig. 6). The frame timing, code group and code are successively detected by performing the search m times (m : time of search operations).

As indicated by ③ in Fig. 7, when the spread codes is identified, it is determined for the paths detected in the same slot whether the multipath is present or not based on whether the same spread codes are detected for a time period not exceeding a predetermined time (S16 in Fig. 6). For example, in the slot at the left end, two paths are detected within the predetermined time, and both exhibit the spread codes of "C₃" so that the latter path is determined as the multipath, and is deleted. Two paths detected in the second left slot are detected within the predetermined time, but exhibit different spread codes "C₇" and "C₂" so that these are determined as carrier waves coming from different base stations,

respectively. Further, two paths in the slot at the right end are not detected within the predetermined time, and therefore are determined that these are not multipath.

Again, the flowchart of Fig. 6 will be described. Microcomputer 4 then instructs demodulator 8 and decoder 9 to start demodulation and decoding of the received data (S17). Demodulator 8 and decoder 9 start the demodulation and decoding in accordance with the instructions sent from microcomputer 4 (S18). In this processing, the multipath is already deleted so that the times required for demodulation and decoding can be short.

Microcomputer 4 performs the processing of determining validity/invalidity of the received data in parallel with the processing by demodulator 8 and decoder 9 (S19). If the received data is valid, the received data is stored in a table 31. If invalid, microcomputer 4 instructs demodulator 8 and decoder 9 to stop the processing. Since processing by microcomputer 4 in steps S13, S16, S17 and S19, the processing by frame timing and code group detector 6 and code detector 7 in steps S14 and S15, and the processing by demodulator 8 and decoder 9 in step S18 can be performed in parallel with each other so that these can be performed as pipeline processing, whereby the cell search can be performed further fast.

The processing in steps S13 - S19 described above are performed for $i = 0 - n'-1$, and the processing is effected on the detected paths of n' in number. When the processing on the detected paths of n' in number is completed, the processing returns to step S11, and processing for the next search ranges is successively performed.

According to the mobile communication terminal of the embodiment, as described above, one slot is divided into a plurality of search ranges, and identification of the spread codes, deletion of the multipath, and demodulation and decoding of the received data are successively performed in the search ranges thus divided. Therefore, the time required for decoding the multipath can be reduced so that the cell search can be performed fast. Further, it is not necessary to employ a memory of a large capacity, which is required in the prior art for storing information used for

deleting the multipath. Accordingly, the scale of hardware of the mobile communication terminal can be reduced.

5 Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

CLAIMS

1. A mobile communication terminal comprising:
a receiver (2) receiving a radio wave from base stations;
5 a detector (5, 6, 7) detecting spread codes from signals received by
said receiver (2);
a demodulator (8) demodulating the received signals with the spread
codes detected by said detector (5, 6, 7);
a decoder (9) decoding data demodulated by said demodulator (8);
10 and
a control unit (4) controlling cell search process, and stopping signal
processing of the cell search in response to detection of invalid data.
2. The mobile communication terminal according to claim 1,
15 wherein
said control unit (4) determines the invalid data based on
information received from the base station, and stops the processing of said
data.
3. The mobile communication terminal according to claim 2,
20 wherein
said detector (5, 6, 7) includes:
a slot timing detector (5) detecting slot timing from the signals
received by said receiver (2),
25 a code group detector (6) detecting a code group based on the slot
timing detected by said slot timing detector (5), and
a code detector (7) detecting a code based on the slot timing detected
by said slot timing detector (5).
4. The mobile communication terminal according to claim 3,
30 wherein
said control unit (4) stops the processing of received data when the
code group detected by said code group detector (6) is not a predetermined

code.

5. The mobile communication terminal according to claim 4,
wherein

5 said code group detector (6) includes:

 a plurality of code generators (15-1 - 15-N), each of said code
generators (15-1 - 15-M) generating a different code group,

 a dummy code generator (15-(M+1) - 15-N) generating a dummy code
different from the code groups generated by said plurality of code
10 generators (15-1 - 15-M),

 a plurality of correlators (16-1 - 16-N), each of said correlators (16-1 -
16-N) calculating correlation between the signal received by said receiver
(2) and the code generated by the corresponding code generator (15-1 - 15-
N), and

15 a determining unit (18) determining invalidity of the data based on
the calculation result of said plurality of correlators (16-1 - 16-N).

6. The mobile communication terminal according to claim 3,
wherein

20 said control unit (4) stops the processing of the received data if the
code detector (7) detects a code other than the predetermined code.

7. The mobile communication terminal according to claim 6,
wherein

25 said code detector (7) includes:

 a plurality of code generators (19-1 - 19-N), each of said code
generators (19-1 - 19-M) generating a different code,

 a dummy code generator (19-(M+1) - 19-N) generating a dummy code
different from the codes generated by said plurality of code generators (19-
30 1 - 19-M),

 a plurality of correlators (20-1 - 20-N), each of said correlators (20-1 -
20-N) calculating correlation between the data received by said receiver (2)
and the code generated by the corresponding code generator (19-1 - 19-N),

and

a determining unit (22) determining invalidity of the data based on the calculation result of said plurality of correlators (20-1 - 20-N).

- 5 8. A mobile communication terminal comprising:
a receiver (2) receiving a radio wave from base stations;
a detector (5, 6, 7) detecting spread codes from signals received by
said receiver (2),
a demodulator (8) demodulating the received signals with the spread
10 codes detected by said detector (5, 6, 7);
a decoder (9) decoding data demodulated by said demodulator (8);
and
a control unit (4) dividing a slot into a plurality of search ranges,
deleting multipath in said search range and successively decoding the
15 received data by said decoder (9).

9. The mobile communication terminal according to claim 8,
wherein
said control unit (4) stops the decode processing if the received data
20 in said search range is invalid data.

10. A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
25 demodulating the received signals with said detected spread codes;
decoding said demodulated data; and
controlling cell search process, and stopping signal processing of the
cell search if said received data is invalid.

- 30 11. The communication method according to claim 10, wherein
said step of stopping the signal processing of the cell search includes
the step of determining invalid data based on information received from
the base station, and stopping the processing of the data.

12. The communication method according to claim 11, wherein
said step of detecting the spread codes includes the steps of:
detecting slot timing from said received signals,
5 detecting a code group based on said detected slot timing, and
detecting a code based on said detected slot timing.

13. The communication method according to claim 12, wherein
said step of stopping the processing of said received data includes
10 the step of stopping the signal processing of the cell search if the code
group received from the base station is not a predetermined code.

14. The communication method according to claim 13, wherein
said step of stopping the signal processing of the cell search includes
15 the steps of:
generating a plurality of different code groups,
generating a dummy code different from said plurality of generated
code groups,
calculating correlations of said received signals with respect to said
20 plurality of generated code and the dummy code, and
determining invalidity of the data based on a result of said
calculation.

15. The communication method according to claim 12, wherein
25 said step of stopping the processing of said received data includes
the step of stopping the processing of the received data if the code received
from the base station is not a predetermined code.

16. The communication method according to claim 15, wherein
30 said step of stopping the processing of said received data includes
the steps of:
generating a plurality of different codes,
generating a dummy code different from said generated code,

calculating correlations of said received signals with respect to said plurality of generated codes and said dummy code, and
determining invalidity of the data based on a result of said calculation.

5

17. A communication method comprising the steps of:
receiving a radio wave from base stations;
detecting spread codes from said received signals;
deleting multipath of the code already detected;
10 successively demodulating the received data subjected to the
deletion of the multipath with said detected spread codes; and
decoding said demodulated data.

18. The communication method according to claim 17, wherein
15 said decoding processing is not performed in said step of deleting the
multipath if the newly detected code is the multipath.

FIG.1

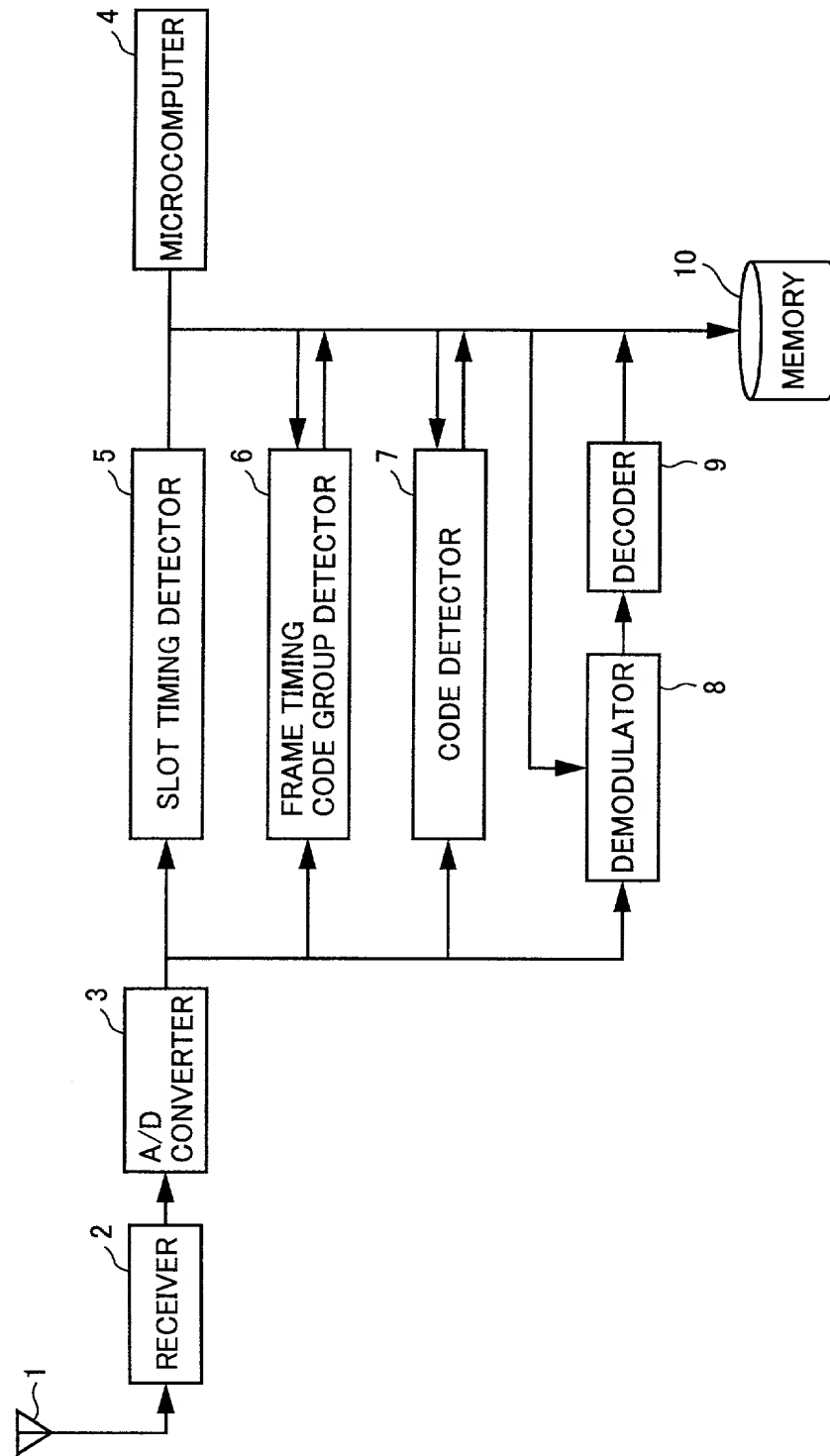


FIG.2

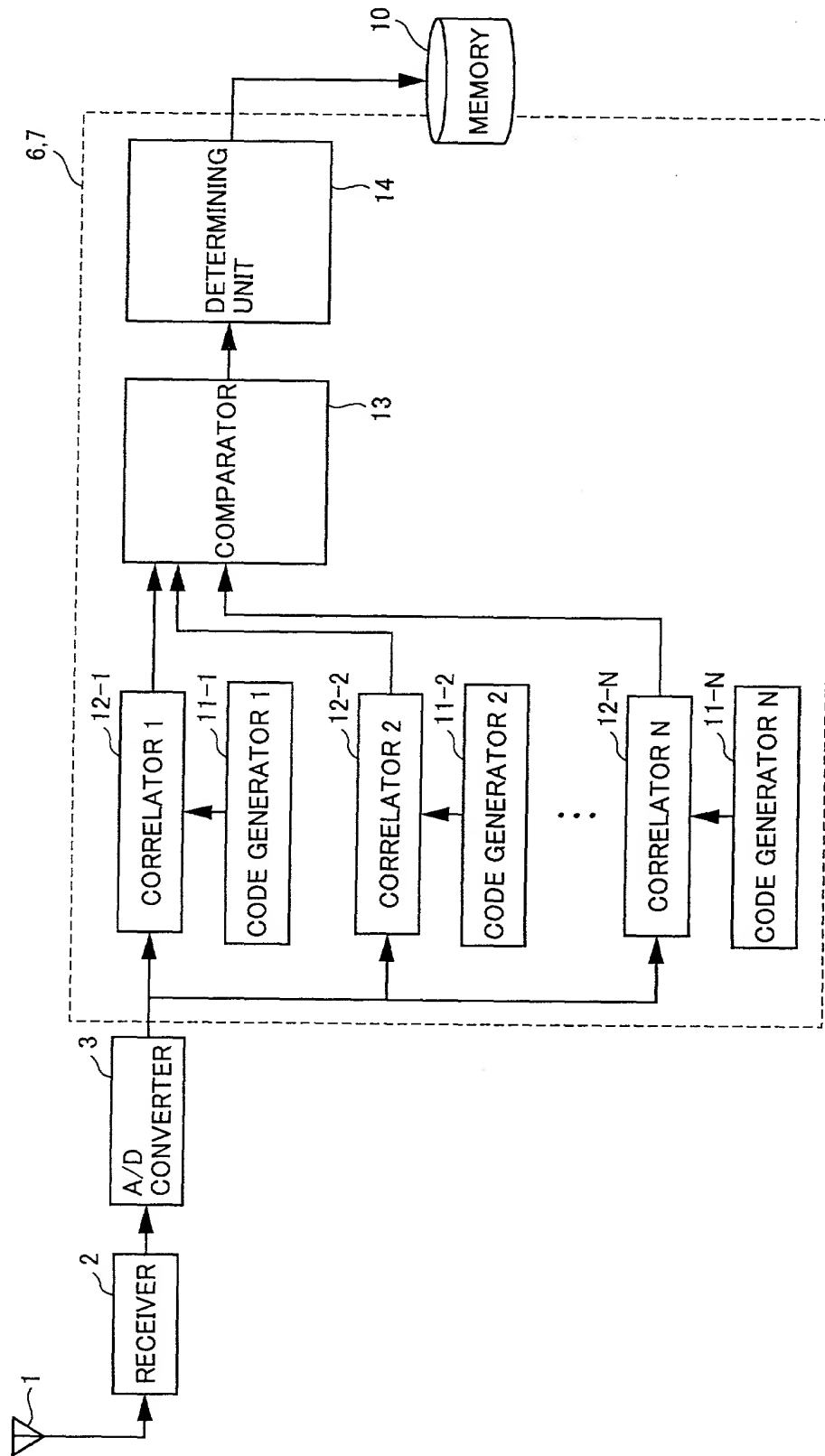


FIG.3

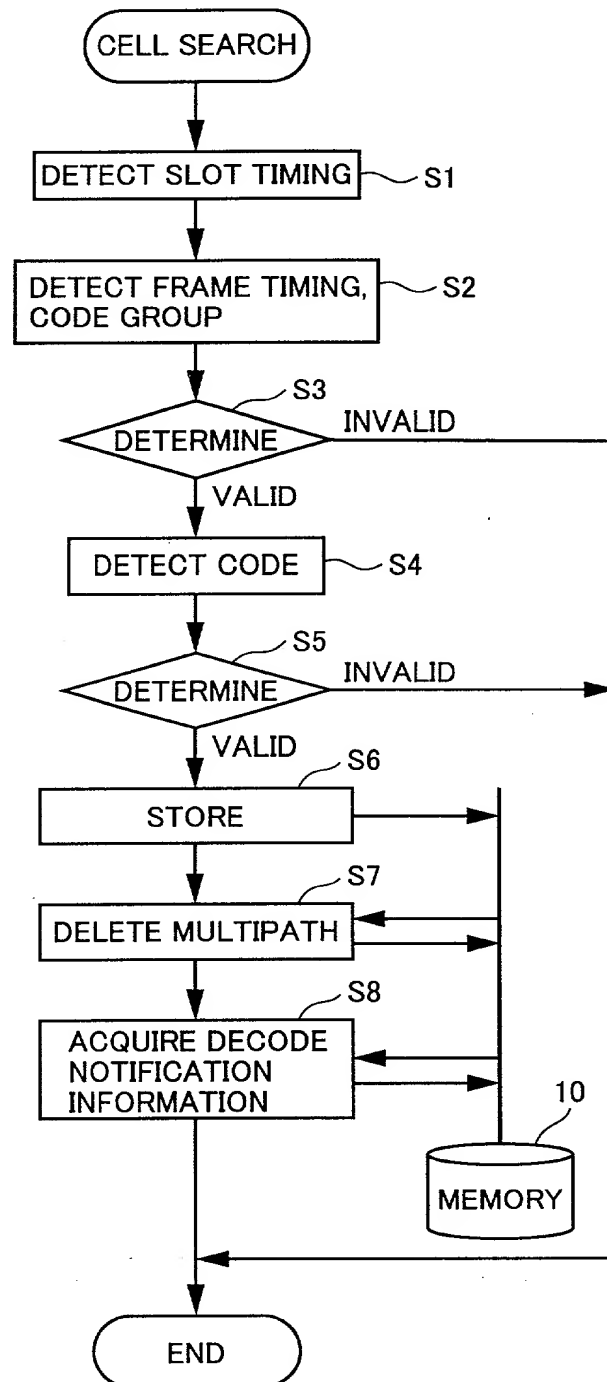


FIG.4

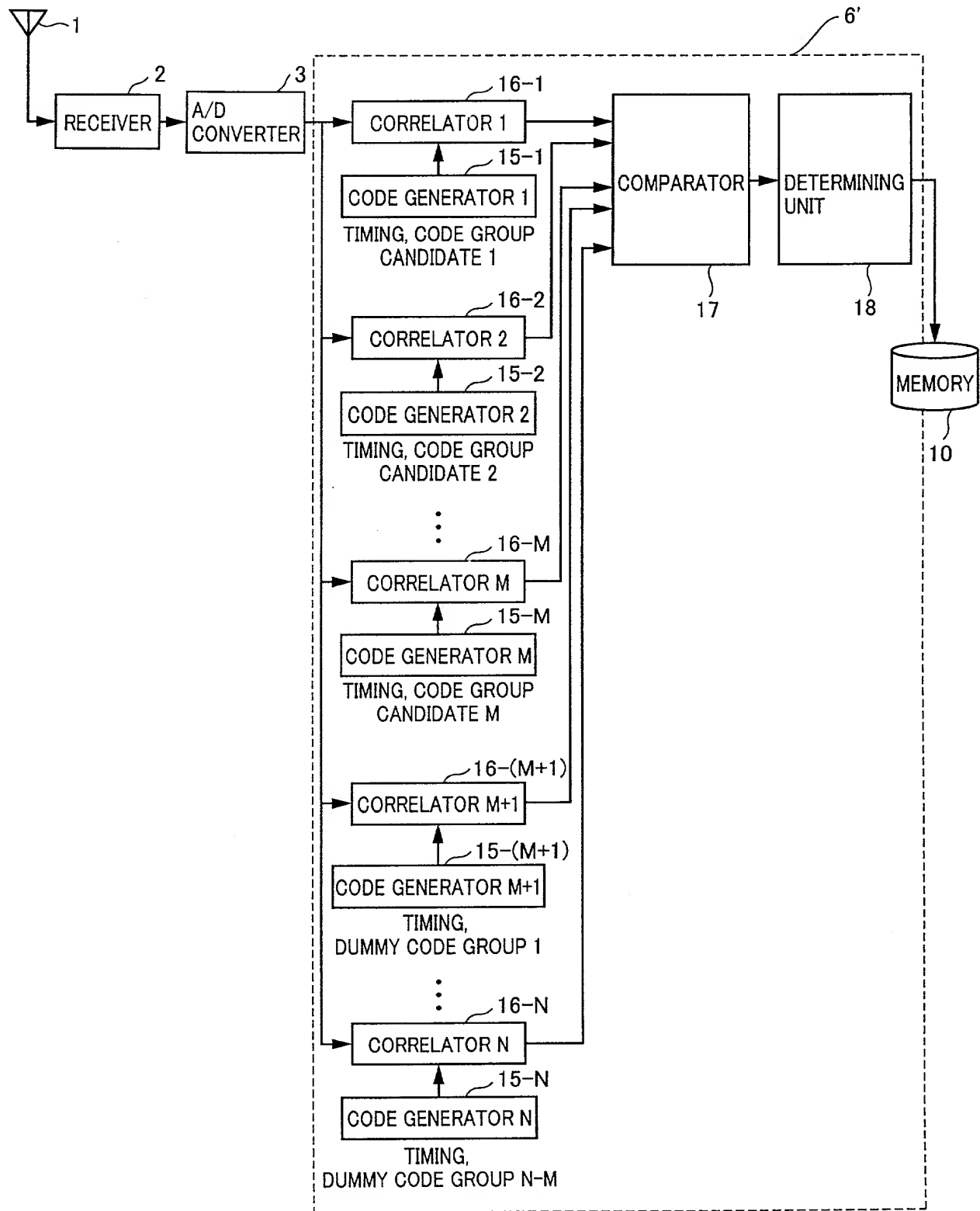
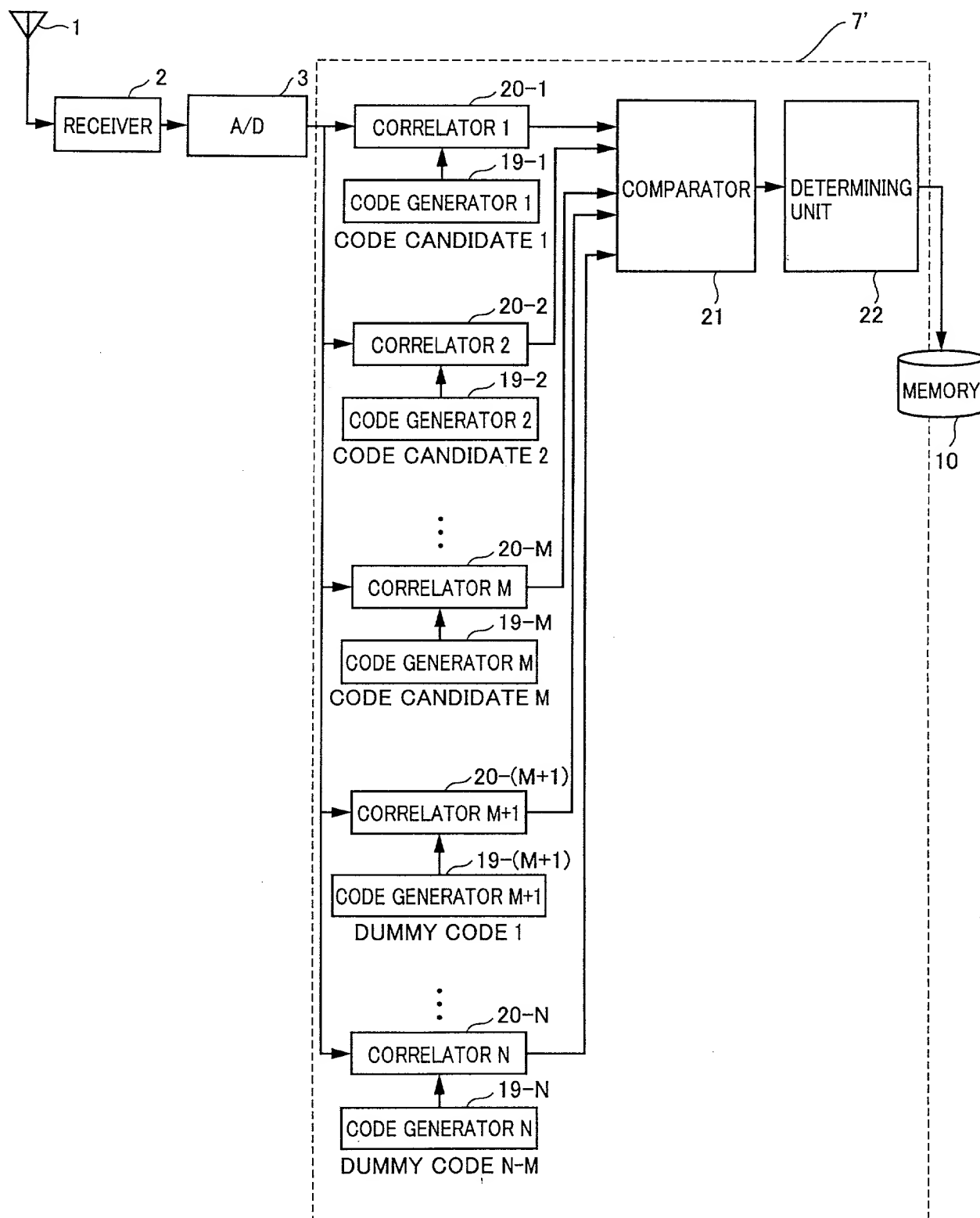


FIG.5



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	

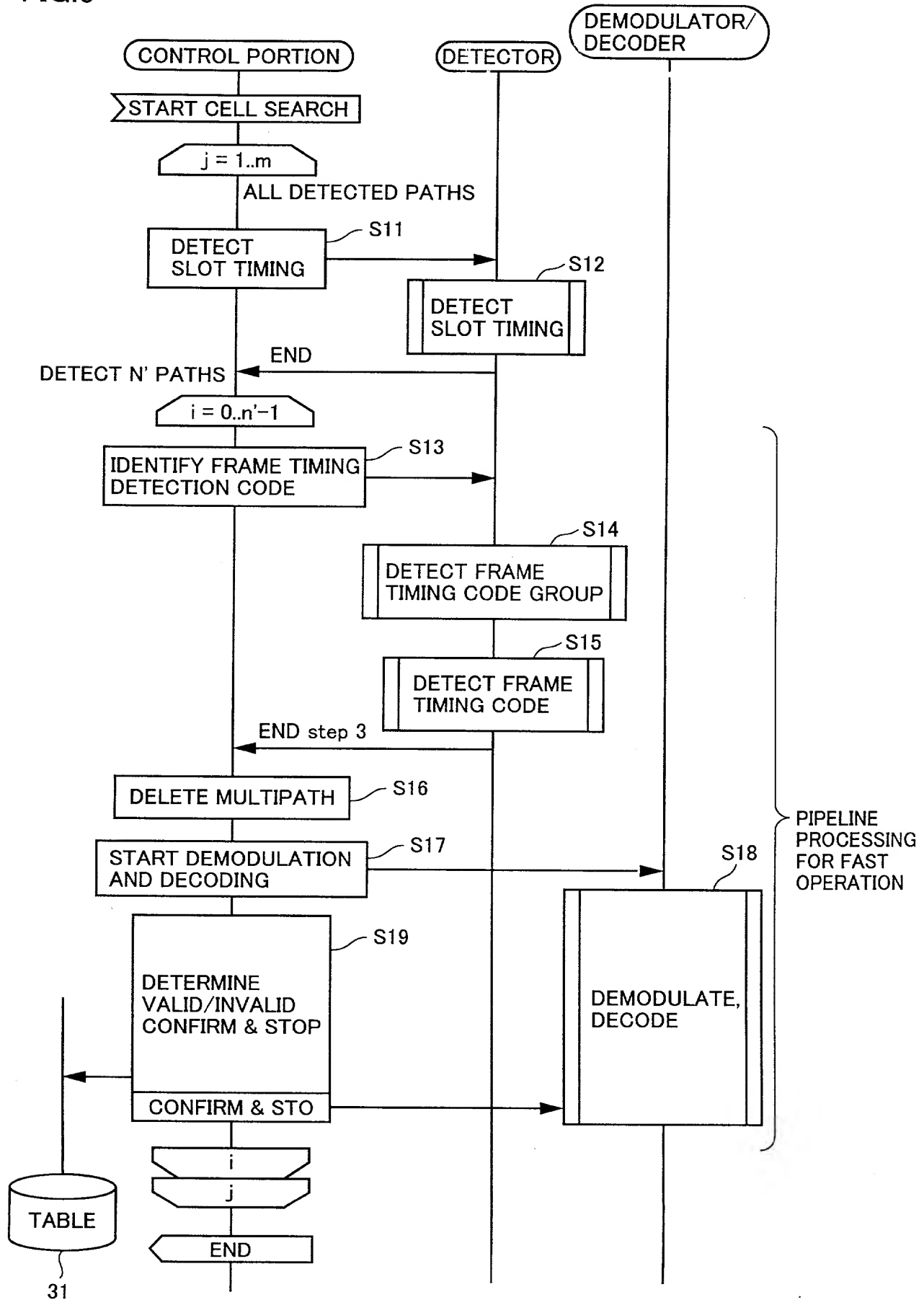


FIG. 7

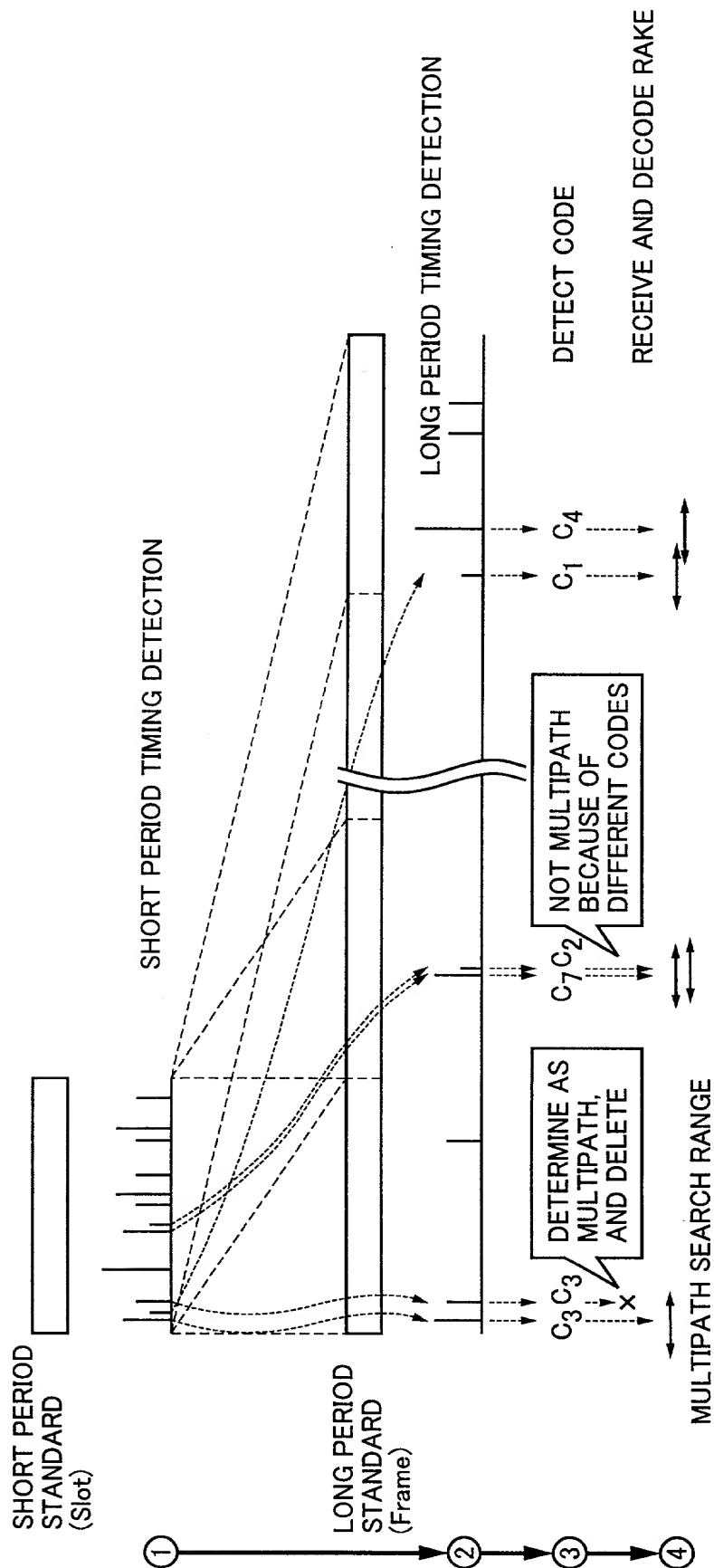


FIG.8 PRIOR ART

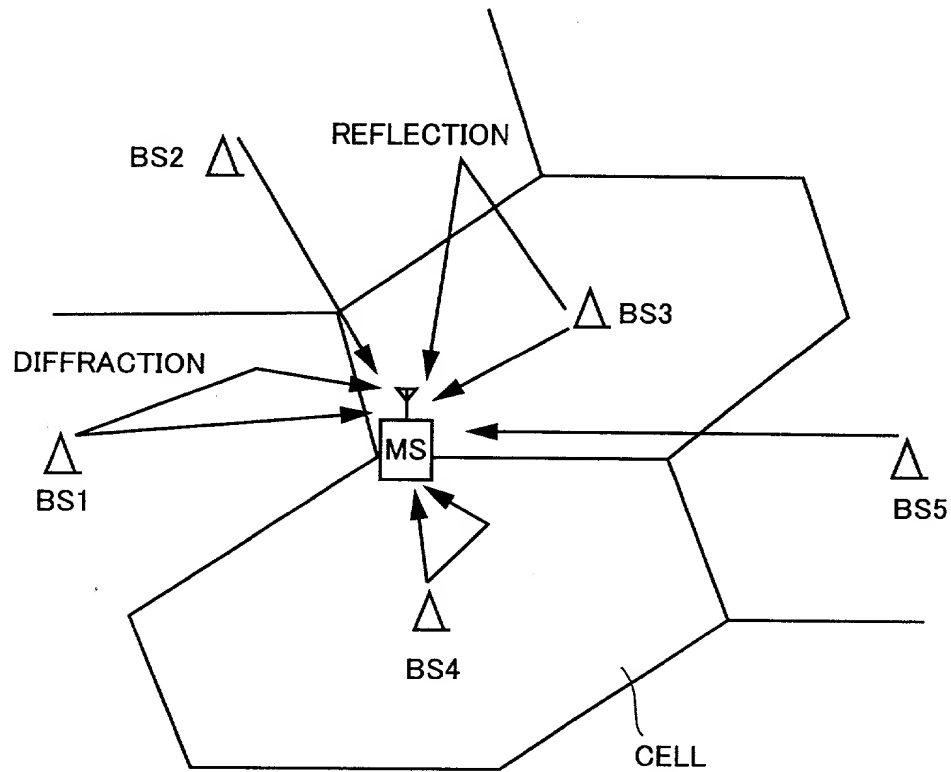
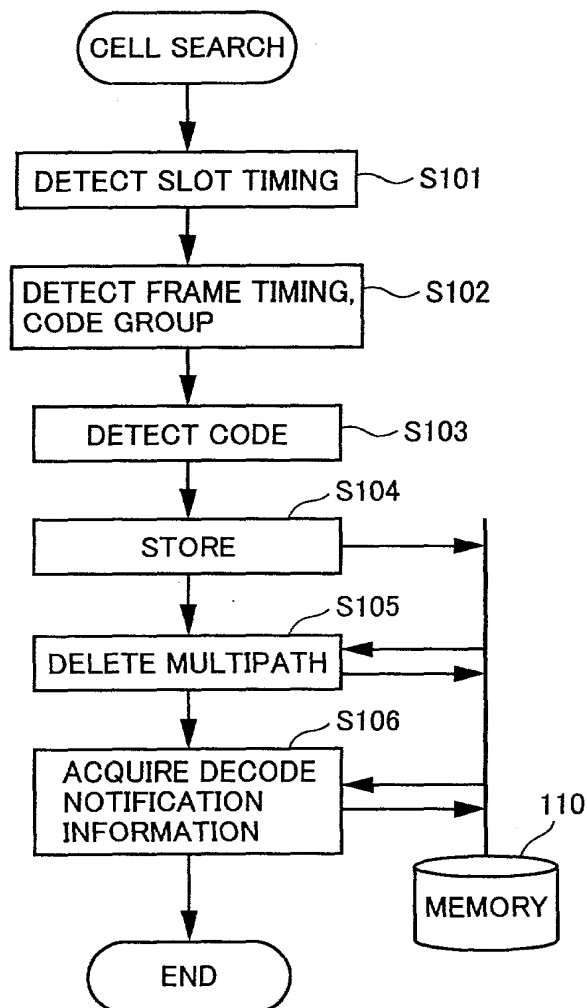


FIG.9 PRIOR ART



Declaration and Power of Attorney For Patent Application

特許出願宣言書

Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

その明細書を
(該当する方に印を付す)

☐ ここに添付する。

☐ _____ 日に出願番号

第 _____ 号として提出し、

_____ 日に補正した。

(該当する場合)

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

私は、連邦規則法典第37部第1章第56条(a)項に従い、本願の審査に所要の情報を開示すべき義務を有することを認める。

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MOBILE COMMUNICATION TERMINAL AND

COMMUNICATION METHOD ✓

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on September 12, 2001 as

Application Serial No. _____

and was amended on September 12, 2001 ✓
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Japanese Language Declaration

私は、合衆国法典第35部第119条にもとづく下記の外国特許出願または発明者証出願の外国優先権利益を主張し、さらに優先権の主張に係わる基礎出願の出願日前の出願日を有する外国特許出願または発明者証出願を以下に明記する：

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior foreign applications
先の外国出願

Priority claimed
優先権の主張

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

☐
Yes
あり

☐
No
なし

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

☐
Yes
あり

☐
No
なし

(Number)
(番号)

(Country)
(国名)

(Day/Month/Year Filed)
(出願の年月日)

☐
Yes
あり

☐
No
なし

私は、合衆国法典第35部第120条にもとづく下記の合衆国特許出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112条第1項に規定の態様で先の合衆国出願に開示されていない限度において、先の出願の出願日と本願の国内出願日またはPCT国際出願日の間に公表された連邦規則法典第37部第1章第56条(a)項に記載の所要の情報を開示すべき義務を有することを認める：

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)
(出願番号)

(Filing Date)
(出願日)

(現況)
(特許済み、係属中、放棄済み)

(Status)
(patented, pending, abandoned)

(Application Serial No.)
(出願番号)

(Filing Date)
(出願日)

(現況)
(特許済み、係属中、放棄済み)

(Status)
(patented, pending, abandoned)

私は、ここに自己の知識にもとづいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽の陳述が本願ないし本願に対して付与される特許の有効性を損うことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

委任状：私は、下記発明者として、以下の代理人をここに選任し、本願の手続を遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する、
(代理人氏名および登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

16- G. Franklin Rothwell, Reg. No. 18,125
E. Anthony Figg, Reg. No. 27,195
Barbara G. Ernst, Reg. No. 30,377
George R. Repper, Reg. No. 31,414
Bart G. Newland, Reg. No. 31,282
Vincent M. DeLuca, Reg. No. 32,408
Celine Jimenez Crowson, Reg. No. 40,357
Joseph A. Hynds, Reg. No. 34,627

Mark I. Bowditch, Reg. No. 40,315
Robert J. Jondle, Reg. No. 33,915
Kenneth M. Fagin, Reg. No. 37,615
Don M. Kerr, Reg. No. 22,720
Jeffrey L. Ihnen, Reg. No. 28,957
Stephen A. Saxe, Reg. No. 38,609
Glenn E. Karta, Reg. No. 30,649
Martha Cassidy, Reg. No. 44,066

書類の送付先：

Rothwell, Figg, Ernst & Manbeck
Suite 701, East Tower
555 13th Street, N.W.
Washington, D.C. 20004
U.S.A.

Send Correspondence to:

直通電話連絡先：(名称および電話番号)

Direct Telephone Calls to: (name and telephone number)

唯一のまたは第一の発明者の氏名	Full name of sole or first inventor	
同発明者の署名	Inventor's signature	Date
住所	Residence	
国籍	Citizenship	
郵便の宛先	Post Office Address	
第2の共同発明者の氏名 (該当する場合)	Full name of second joint inventor, if any	
同第2発明者の署名	Second Inventor's signature	Date
住所	Residence	
国籍	Citizenship	
郵便の宛先	Post Office Address	

(第6またはそれ以降の共同発明者に対しても同様な情報および署名を提供すること。)

(Supply similar information and signature for third and subsequent joint inventors.)